Bitter Lake

Site Description

Location

Water designation number (WDN)	22-0016-00
Legal description	T121N-R54W-Sec. 8-10, 15-17, 20-23, 27-29, 33, 34
County (ies)	Day
Location from nearest town	0.5 miles south of Waubay, SD

Survey Dates and Netting Information

Survey dates	August 26-28, 2014 (FN, GN) September 15, 2014 (EF-WAE)
Gill net sets (n)	8
Electrofishing-WAE (min)	45

Morphometry (Figure 1)

Watershed area (acres)	38,894
Surface area (acres)	>15,000
Maximum depth (ft)	≈30
Mean depth (ft)	unknown

Ownership and Public Access

Bitter Lake is a meandered lake owned by the State of South Dakota and the fishery is managed by SDGFP. Three public access sites are located on Bitter Lake. Two are maintained by SDGFP; the first located on the east shore off Day Co. Highway 1 includes a large parking area, double-lane concrete boat ramp, and dock; while the other located on the west shore off 442nd Avenue includes a smaller gravel parking lot, concrete-plank boat ramp, and dock (Figure 1; Figure 2). The third access, which is privately owned, is located near the Bitter Lake Lodge on the lakes northeast shore.

Watershed and Land Use

Land use within the Waubay Lakes (HUC-10) watershed is primarily agricultural including cropland, pasture or grassland, and small wooded areas (e.g., shelterbelts). Additionally, a portion of the City of Waubay lies within the watershed.

Water Level Observations

No OHWM has been established by the South Dakota Water Management Board on Bitter Lake. On May 6, 2014 the elevation was 1802.6 fmsl; 0.5 ft above the fall 2013 elevation of 1802.1 fmsl. The water level had declined to an elevation of 1802.1 fmsl on October 28, 2014.

Fish Management Information

Primary species	walleye, yellow perch
Other species	black bullhead, black crappie, common carp, northern pike, rock bass, spottail shiner, white bass, white sucker
Lake-specific regulations	walleye: minimum length 15”
Management classification	warm-water permanent
Fish consumption advisories	Mercury: walleye (all sizes); northern pike (> 30”). See the South Dakota fishing handbook for more details on meal and portion size recommendations. Also see Department of Health website: http://doh.sd.gov/Fish/Default.aspx for more information.

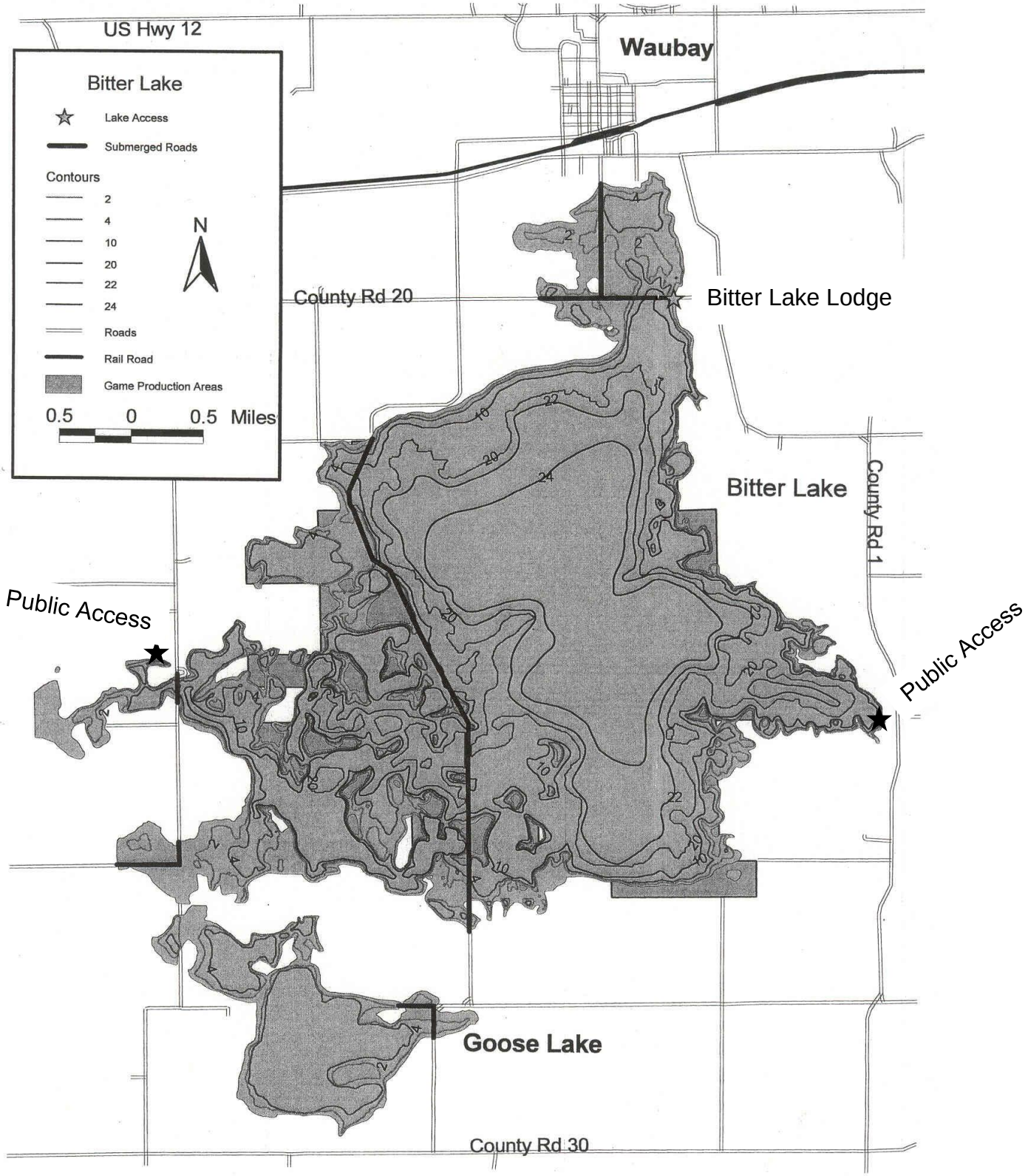

Figure 1. Bitter Lake, Day County, South Dakota contour map.

Figure 2. Map depicting geographic location of Bitter Lake from Waubay, Day County, South Dakota. Also noted are public access and standardized net locations for Bitter Lake. BFN=frame nets; BGN=gill nets

Management Objectives

1) Maintain a mean gill net CPUE of stock-length walleye ≥ 10, a PSD of 30-60, and a PSD-P of 5-10.

2) Maintain a mean gill net CPUE of stock-length yellow perch ≥ 30, a PSD of 30-60, and a PSD-P of 5-10

Results and Discussion

Bitter Lake is a natural lake located south of Waubay, South Dakota in northeast South Dakota. Prior to the 1990's, Bitter Lake was a 3,000 acre alkaline slough with an approximate depth of 3 ft. High water conditions since the mid to late 1990's have increased the water depth and surface area of Bitter Lake. Currently, Bitter Lake covers in excess of 15,000 acres and is managed as a walleye and yellow perch fishery.

Primary Species

Walleye: The mean gill net CPUE of stock-length walleye was 38.8 (Table 1) and above the minimum objective (≥ 10 stock-length walleye/net night; Table 3). Since 2005, the mean gill net CPUE has ranged from a low of 9.1 (2008) to a high of 50.6 (2010; Table 2). Currently, relative abundance is high.

Gill net captured walleye ranged in TL from 11 to 67 cm (4.3 to 26.4 in), had a PSD of 8 and a PSD-P of 3 (Table 1; Figure 3). The PSD and PSD-P were both below the management objectives (defined as PSD of 30-60 and a PSD-P of 5-10; Table 3; Figure 3). Approximately 94% of walleye in the gill net catch were below the 381-mm (15-in) minimum length restriction (Figure 3).

Otoliths collected from a sub-sample of gill net captured walleye revealed the presence of 10 year classes (2002, 2005, 2006 and 2008-2014; Table 4). The naturally-produced 2011 year class was the most represented and comprised 82% of walleye in the gill net catch (Table 4; Table 6). Decline in PSD values in recent years (i.e., 2012-2014) can be attributed to growth of the strong 2011 cohort into the stock-quality length category coupled with a decrease in the number of individuals being sampled from the strong 2009 year class (Table 4; Table 5; Figure 3). In 2014, few age-0 walleye were captured by gill nets or during fall night electrofishing, which suggests that only a weak cohort was produced (Table 1; Table 4).

Walleye in Bitter Lake exhibited fast growth and easily surpassed quality-length (38 cm; 15 in) by age-3 from 2005-2012 (Table 5). From 2005-2012, weighted mean TL at capture values of age-3 walleye ranged from 410 to 464 mm (16.1 to 18.3 in; Table 5). Unfortunately, limited prey fish production (e.g., yellow perch, white bass, etc.) in conjunction with the presence of the strong 2011 year class, which currently dominates the population, has resulted in slower growth. Weighted mean TL at capture values for the 2011 year class were 252, 275, and 322 mm (9.9, 10.8 and 12.7 in) at ages 1-3, respectively (Table 5). For comparison, the equally strong 2009 cohort had weighted

mean TL capture values of 307, 397, and 446 mm (12.1, 15.6, and 17.6 in) at those same ages (i.e., 1-3; Table 5). Gill net captured walleye had mean Wr values that ranged from 69 to 100 for all 10-mm length groups represented. A decreasing trend in condition was apparent as TL increased. Walleye from the strong 2011 cohort, which were in the stock-quality length category, had a mean Wr of 91.

Yellow Perch: The mean gill net CPUE of stock-length yellow perch was 5.8 (Table 1) and below the minimum objective (≥ 30 stock-length perch/net night; Table 3). Since 2005, mean gill net CPUE values have ranged from a low of 2.6 (2005, 2007) to a high of 67.3 (2012; Table 2). Based on the 2014 gill net CPUE, relative abundance appears to be low.

Gill net captured yellow perch ranged in TL from 11 to 33 cm (4.3 to 13.4 in; Figure 4). The PSD was 80 and the PSD-P was 48, both exceeded management objectives of 30-60 and 5-10, indicating a population comprised of larger (i.e., ≥20 cm; 8 in) individuals (Table 1; Table 3; Figure 4).

Otoliths were collected from a sub-sample of gill net captured yellow perch. Age structure information suggested the presence of six consecutive year classes (2008-2013; Table 7). Year classes produced in 2009 and 2011 were the most abundant and collectively comprised approximately 60% of yellow perch in the gill net catch (Table 7). Limited recruitment in recent years coupled with growth of older cohorts, primarily 2009 and 2011, has resulted in the increased PSD and PSD-P (Table 3; Figure 4).

Yellow perch in Bitter Lake display fast growth and typically approach or surpass quality-length (20 cm; 8 in) by age 2 (Table 8). Since 2009, weighted mean TL at capture values for age-2 yellow perch have ranged from 195 to 257 mm (7.7 to 10.1 in); while the weighted mean TL at capture for age-3 fish has ranged from 239 to 292 mm (9.4 to 11.5 in; Table 8). In 2014, the weighted mean TL at capture for age-2 and age-3 yellow perch was 195 and 239 mm (7.7 and 9.4 in), respectively (Table 8). As with most populations, males tend to be smaller at a given age than females, particularly at older ages (Table 8). Condition of gill net captured yellow perch was high with mean Wr values > 100 for all length categories (e.g., stock to quality) sampled.

Other Species

Northern Pike: The mean gill net CPUE of stock-length northern pike was 1.5 (Table 1). The 2014 gill net CPUE represented a decrease from the 2013 CPUE of 4.1 (Table 2), but still indicated moderate relative abundance.

Northern pike captured in the gill net sample ranged in TL from 56 to 96 cm (22.0 to 37.8 in), had a PSD of 100 and a PSD-P of 50 (Table 1; Figure 5). No age or growth information was collected. The majority of northern pike in the gill net catch were in the quality-preferred length category, which had a mean Wr of 75.

Other: Common carp, white bass and rock bass were other fish species captured in low numbers during the 2014 fish community survey on Bitter Lake (Table 1).

Management Recommendations

1) Conduct fish population assessment surveys utilizing gill nets on an annual basis (next survey scheduled in summer 2015) to monitor fish relative abundance, fish population size structures, fish growth, and stocking success.

2) Conduct fall night electrofishing on an annual basis to monitor age-0 walleye relative abundance.

3) Collect otoliths from walleye and yellow perch to assess age structure and growth rates of each population.

4) Stock walleye (≈500 fry/acre) to establish additional year-classes if gill netting and/or fall night electrofishing CPUE of age-0 walleye results warrant [i.e., low gill net CPUE of sub-stock (< 25 cm; 10 in) walleye and/or fall night electrofishing CPUE of age-0 walleye < 75 fish/hour].

5) Re-evaluate the 381-mm (15 in) minimum length limit on walleye. Growth has slowed in recent years and may no longer meet criteria set forth in the South Dakota Walleye Toolbox (Lucchesi and Blackwell 2009).

Table 1. Mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for various fish species captured in experimental gill nets and electrofishing in Bitter Lake, 2014. Confidence intervals include 80 percent (± CI-80) or 90 percent (± CI-90). COC= common carp; NOP= northern pike; WAE= walleye; WHB= white bass; YEP= yellow perch

	Abundance		Stock Density Indices				Condition	
Species	CPUE	CI-80	PSD	CI-90	PSD-P	CI-90	Wr	CI-90
Gill nets								
COC	1.4	0.7	91	17	91	17	113	5
NOP	1.5	0.8	100	0	50	27	75	4
WAE	38.8	6.5	8	3	3	2	91	<1
WHB	1.9	1.1	100	0	100	0	106	1
YEP	5.8	2.0	80	10	48	13	111	2
Electrofishing								
WAE[1]	9.6	---	---	---	---	---	---	---

[1] Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour

Table 2. Historic mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish for various fish species captured using experimental gill nets and electrofishing in Bitter Lake, 2005-2014. BLB= black bullhead; BLC= black crappie; COC= common carp; NOP= northern pike; ROB= rock bass; SPS=spottail shiner; WAE= walleye; WHB= white bass; WHS=white sucker; YEP= yellow perch

	CPUE									
Species	2005	2006[3]	2007[3]	2008	2009	2010	2011	2012	2013	2014
Frame nets										
BLB	---	---	---	---	---	---	---	---	0.2	---
COC	---	---	---	---	---	---	---	---	1.4	---
NOP	---	---	---	---	---	---	---	---	2.3	---
WAE	---	---	---	---	---	---	---	---	5.7	---
WHB	---	---	---	---	---	---	---	---	0.2	---
YEP	---	---	---	---	---	---	---	---	0.2	---
Gill nets										
BLC	0.0	0.1	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.0
COC	0.1	0.0	0.3	0.1	0.0	0.3	1.4	0.1	0.0	1.4
NOP	0.4	0.8	0.3	0.4	0.5	1.0	1.5	5.0	4.1	1.5
ROB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
SPS[1]	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
WAE	20.0	31.8	16.9	9.1	11.0	50.6	20.1	19.8	18.0	38.8
WHB	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	1.9
WHS	0.3	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.4	0.0
YEP	2.6	11.8	2.6	4.1	20.8	25.9	39.0	67.3	21.4	5.8
Electrofishing										
WAE[2]	90.1	0.0	440.0	136.9	294.0	0.0	377.0	36.0	34.0	9.6

[1] All fish sizes.
[2] Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour
[3] Monofilament gill net mesh size change (0.75”, 1.00”, 1.25”, 1.50”, 2.00” and 2.50”)

Table 3. Mean catch rate (CPUE; gill nets = catch/net night) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for selected species captured in experimental gill nets from Bitter Lake, 2005-2014. WAE= walleye; YEP= yellow perch

Species	2005	2006[1]	2007[1]	2008	2009	2010	2011	2012	2013	2014	Objective
Gill nets											
WAE											
CPUE	20	32	17	9	11	51	20	20	18	39	≥ 10
PSD	96	50	91	81	24	19	76	58	30	8	30-60
PSD-P	1	8	10	8	2	3	4	4	6	3	5-10
Wr	89	96	90	92	94	102	93	86	83	91	---
YEP											
CPUE	3	12	3	4	21	26	39	67	21	6	≥ 30
PSD	76	64	86	42	34	29	84	59	78	80	30-60
PSD-P	43	49	29	24	13	22	14	40	49	48	5-10
Wr	113	97	114	114	116	106	110	105	110	111	---

[1] Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

Table 4. Year class distribution based on the expanded age/length summary for walleye sampled in gill nets and associated stocking history (# stocked x 10,000) from Bitter Lake, 2009-2014.

	Year Class													
Survey Year	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
2014	12	18	13	280	2	12	1		1	1			1	
2013	---	3	3	102	3	33	3	1		2		1	1	
2012[1]	---	---	8	107	15	73	4			2				1
2011[1]	---	---	---	108	6	137	11	1		2			1	1
2010[1]	---	---	---	---	5	326	42	16		15		1	3	1
# stocked														
fry		750						1000		905				
sm. fingerling														
lg. fingerling														

[1] Older walleye were sampled, but are not reported in this table.

Table 5. Weighted mean TL (mm) at capture for walleye age-0 through age-10 sampled in experimental gill nets (expanded sample size) from Bitter Lake, 2005-2014. Note: sampling was conducted at approximately the same time during each year allowing comparisons among years to monitor growth trends.

	Age										
Year	0	1	2	3	4	5	6	7	8	9	10
2014[1]	120(12)	202(18)	255(13)	322(280)	417(2)	486(12)	575(1)	---	540(1)	551(1)	---
2013[1]	184(3)	211(3)	275(102)	387(3)	471(33)	498(3)	500(1)	---	529(2)	---	592(1)
2012[1]	139(8)	252(107)	387(15)	446(73)	527(4)	---	---	592(2)	---	---	---
2011[1]	155(108)	312(6)	397(137)	464(11)	473(1)	---	545(2)	---	---	653(1)	626(1)
2010[1]	185(5)	307(326)	406(42)	443(16)	---	513(15)	---	561(1)	543(3)	635(1)	---
2009[1]	133(123)	287(53)	358(15)	458(3)	474(13)	---	---	484(1)	---	496(1)	652(1)
2008[1]	130(28)	271(19)	357(1)	431(50)	---	---	509(4)	510(2)	495(1)	598(1)	---
2007	170(1)	---	402(97)	---	466(3)	497(14)	484(6)	504(4)	455(1)	599(3)	544(6)
2006	191(1)	326(131)	413(5)	461(9)	468(66)	---	490(31)	509(5)	584(3)	442(4)	---
2005	165(64)	295(2)	383(7)	410(52)	429(47)	440(15)	455(14)	438(16)	478(2)	---	---

[1] Older walleye were sampled, but are not reported in this table.

Table 6. Stocking history including size and number for fishes stocked into Bitter Lake, 2001-2014. WAE= walleye

Year	Species	Size	Number
2005	WAE	fry	9,050,000
2007	WAE	fry	10,000,000
2013	WAE	fry	7,500,000

Table 7. Year class distribution based on the age/length summary for yellow perch sampled in gill nets from Bitter Lake, 2010-2014.

	Year Class							
Survey Year	2014	2013	2012	2011	2010	2009	2008	2007
2014		8	3	19	7	10	1	
2013	---		1	65	20	82	3	
2012	---	---	9	240	53	251	12	2
2011	---	---	---	145	28	268	11	6
2010	---	---	---	---		152	48	8

Table 8. Weighted mean TL (mm) at capture by gender for yellow perch captured in experimental gill nets (expanded sample size) from Bitter Lake, 2009-2014.

	Age						
Year	0	1	2	3	4	5	6
2014							
Male	---	---	195(1)	241(2)	266(2)	255(2)	---
Female	---	135(8)	196(2)	239(15)	263(4)	314(8)	313(1)
Combined	---	135(8)	195(3)	239(19)	263(7)	302(10)	313(1)
2013							
Male	---	---	186(13)	219(2)	241(26)	---	---
Female	---	147(1)	203(52)	273(20)	280(53)	289(4)	---
Combined	---	147(1)	200(65)	267(20)	268(82)	289(3)	---
2012							
Male	126(10)	144(65)	223(28)	232(41)	---	---	---
Female	---	157(163)	232(22)	270(209)	303(12)	338(2)	---
Combined	126(9)	153(240)	226(53)	264(251)	303(12)	338(2)	---
2011							
Male	100(116)	163(10)	203(55)	---	---	---	---
Female	97(14)	174(15)	233(213)	292(11)	323(6)	---	---
Combined	98(145)	172(28)	227(268)	292(11)	323(6)	---	---
2010							
Male	---	161(31)	238(1)	231(1)	---	---	---
Female	---	175(117)	258(47)	294(7)	---	---	---
Combined	---	172(152)	257(48)	286(8)	---	---	---
2009							
Male	92(26)	165(7)	223(2)	---	266(1)	---	---
Female	92(10)	173(101)	239(53)	264(2)	---	---	---
Combined	92(36)	172(108)	238(55)	264(2)	266(2)	---	---

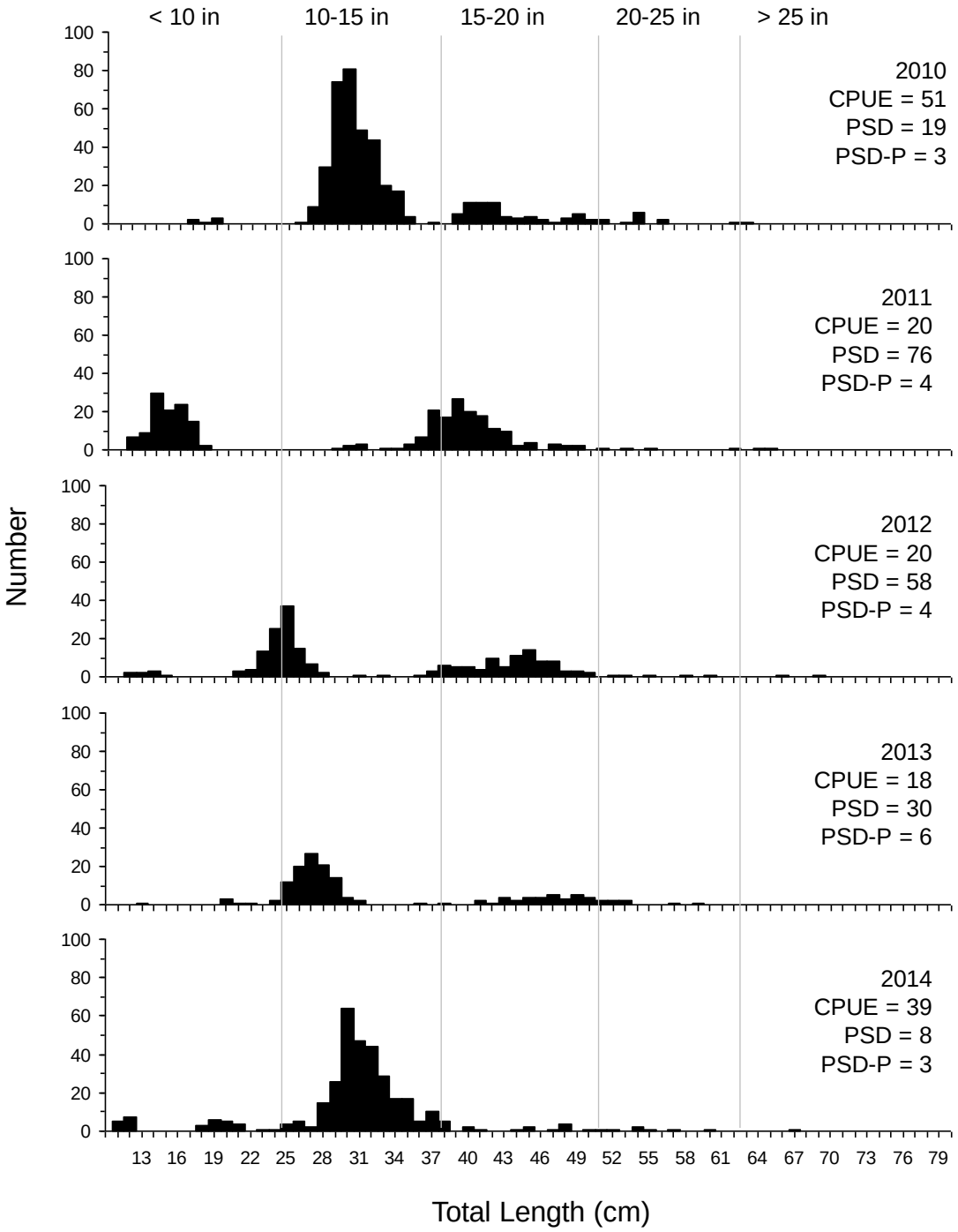

Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for walleye captured using experimental gill nets in Bitter Lake, 2010-2014.

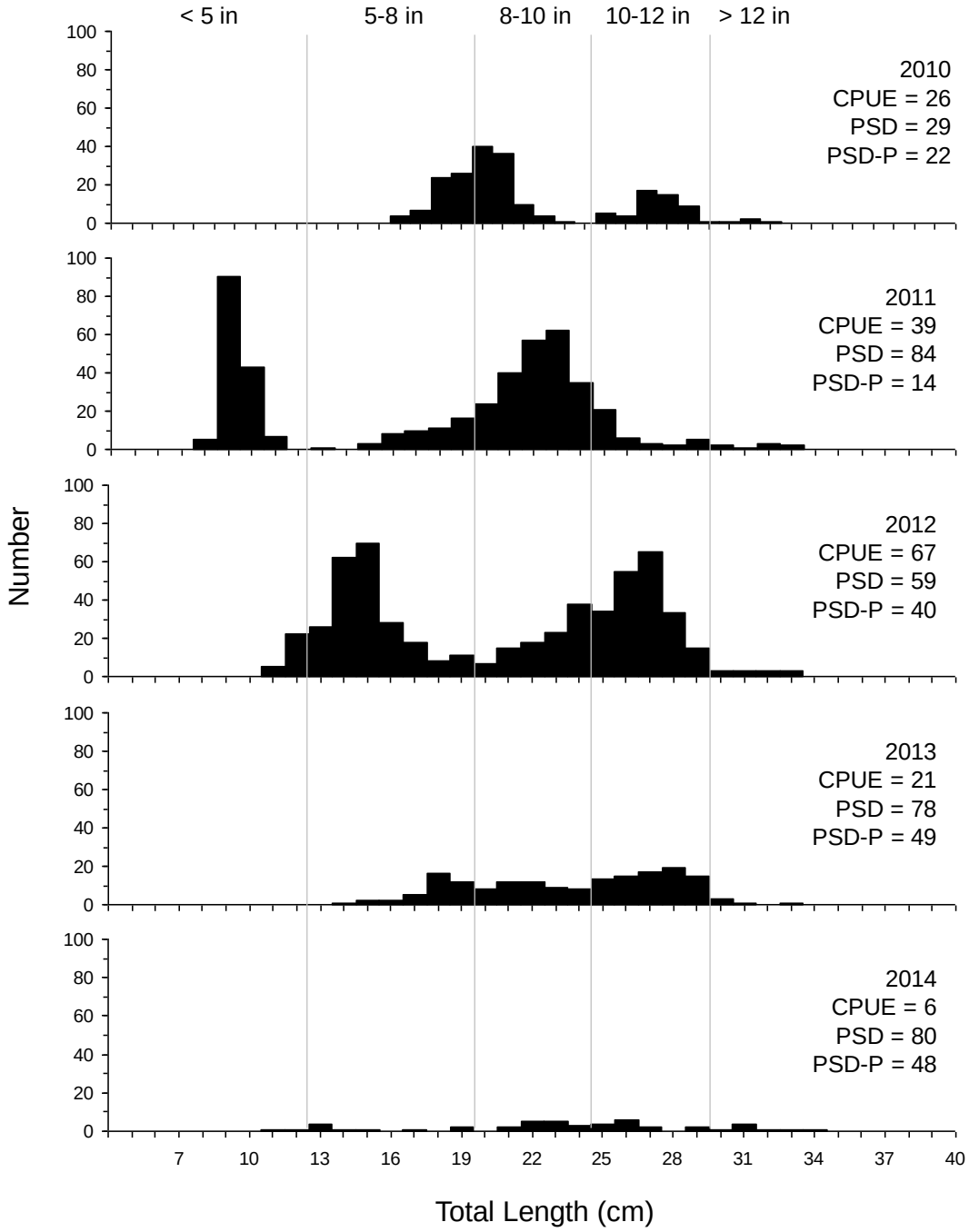

Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for yellow perch captured using experimental gill nets in Bitter Lake, 2010-2014

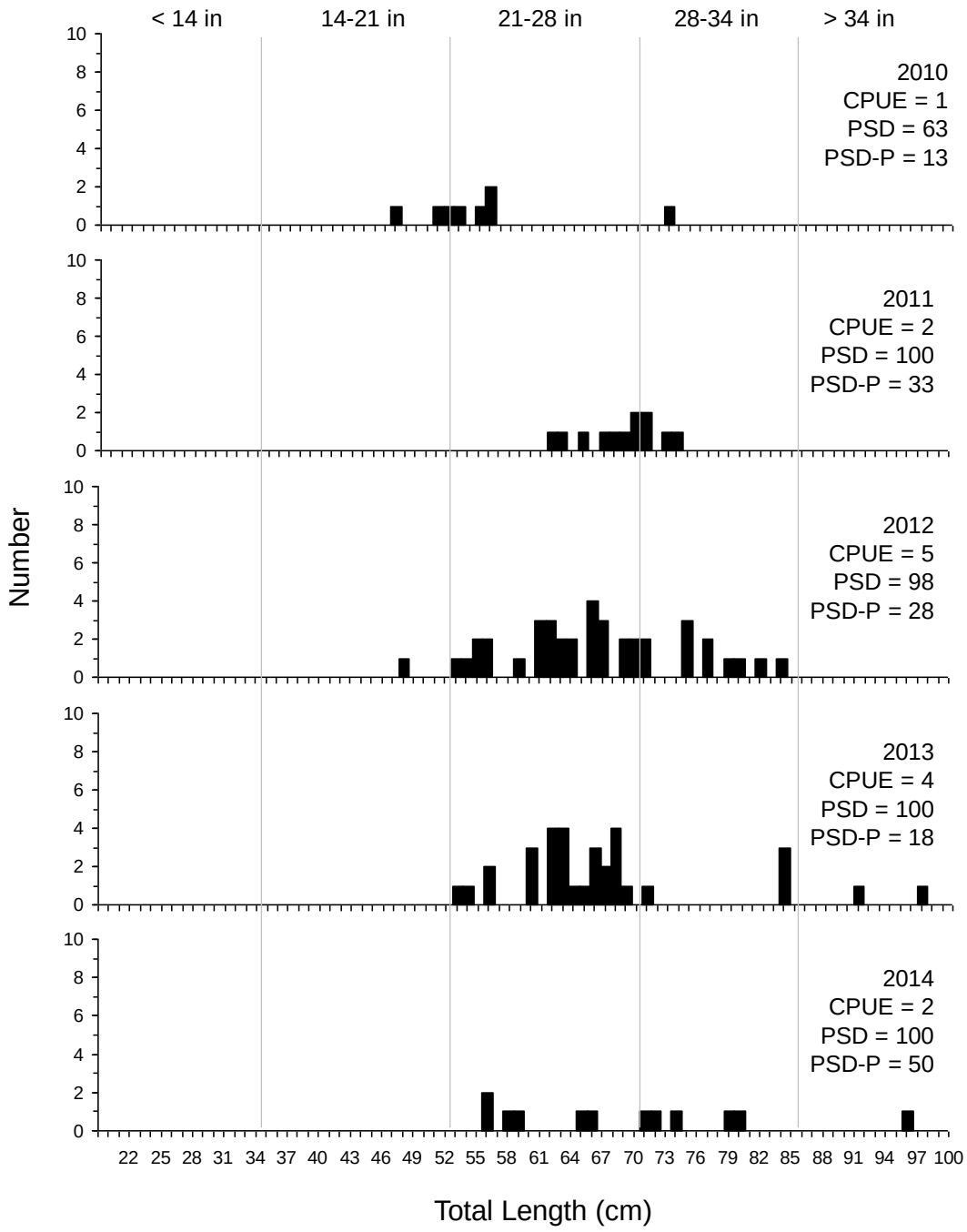

Figure 5. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for northern pike captured using experimental gill nets in Bitter Lake, 2010-2014.